

SOME TREMATODES OF MAMMALS IN LOUISIANA

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ABSTRACT

The following trematodes were collected from mammals in southern Louisiana: *Alaria mustelae* Bosma, 1931 from the raccoon, *Procyon lotor* (Linn.); *Fibricola cratera* (Barker and Noll, 1915) Dubois, 1932 from raccoons, opossums (*Didelphis virginiana* Kerr), and a mink, *Mustela vison* Schreber; *F. lucida* (La Rue and Bosma, 1927) Dubois and Rausch, 1950 from a raccoon and a gray fox, *Urocyon cinereoargenteus* (Schreber); *Pharyngostomoides procyonis* Harkema, 1942 from the raccoon; *Heterobilharzia americana* Price, 1929 from raccoons and opossums; *Apo-phallus venustus* (Ransom, 1920) Cameron, 1936 from raccoons; *Parametorchis complexus* (Stiles and Hassal, 1894) Skrjabin, 1913 from raccoons; *Baschkirovitrema incrassatum* (Dies., 1850) Skrjabin, 1944 from an otter, *Lutra canadensis* (Schreber); *Brachylaima virginianum* Dickerson, 1930 from opossums; *Gyrosoma singulare* Byrd, Bogitsh, and Maples, 1961 from raccoons; *Hasstilesia texensis* Chandler, 1929 from swamp rabbits, *Sylvilagus aquaticus* (Bachman); *Maritreminoides nettae* (Gower, 1938) Rankin, 1939 from raccoons; and *Rhopalias macracanthus* Chandler, 1932 from opossums. *Brachylaima virginianum*, *Fibricola cratera*, *F. lucida*, *Hasstilesia texensis*, *Heterobilharzia americana*, and *Rhopalias macracanthus* have been previously reported from Louisiana; the other species are new locality records. The raccoon is a new host record for adult *Alaria mustelae*. Diagnoses are presented for species representing state records along with pertinent notes on the epidemiology and zoogeography of each.

INTRODUCTION

During our studies on the life cycle of *Alaria marcianae* (La Rue, 1917) Walton, 1949 in Louisiana we had the opportunity to examine other mammals for trematodes. All mammals reported herein were collected in southern Louisiana

from an area bordered on the west by the Atchafalaya basin and on the east by Lake Maurepas. The mammals were collected by leg traps set in and around cypress-tupelo swamps.

The following mammals were examined for trematodes, one mink, *Mustela vison* Schreber; one gray fox, *Urocyon cinereoargenteus* (Schreber); one striped skunk, *Mephitis mephitis* (Schreber); two river otters, *Lutra canadensis* (Schreber); two swamp rabbits, *Sylvilagus aquaticus* (Bachman); twelve opossums, *Didelphis virginiana* Kerr; and thirty raccoons, *Procyon lotor* (Linn.).

Trematodes were fixed in steaming 10% formalin and stained in Semichon's aceto-carmine. All measurements are in micrometers unless otherwise stated; means are followed by the ranges in parentheses. Line drawings were prepared with the aid of a microprojector. Representative specimens for which diagnoses are given were deposited in the Manter Laboratory, University of Nebraska State Museum.

The following is a list of trematodes we found from mammals that have been previously reported from Louisiana: From the mink we found *Fibricola cratera* (Barker and Noll, 1915) Dubois, 1932 in the small intestine; both swamp rabbits harbored thousands of *Hasstilesia texensis* Chandler, 1929 in the small intestine; in opossums *F. cratera* and *Rhopalias macracanthus* Chandler, 1932 occurred in the small intestine of all twelve, *Brachylaima virginianum* Dick-

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erson, 1930 in the small intestine of eight, and *Heterobilharzia americana* Price, 1929 in the mesenteric venules of three; from gray fox we have a single specimen of *F. lucida* (La Rue and Bosma, 1927) Dubois and Rausch, 1950 from the small intestine; no trematodes were found in the skunk; and in the raccoons we collected *F. cratera* and *F. lucida* from the small intestine of ten and one respectively, and *H. americana* in the mesenteric venules of four.

Lumsden and Zischke (1961) adequately described *Fibricola cratera*, *F. lucida*, *Hasstilesia texensis*, and *Brachylaima virginianum* from Louisiana mammals. Malek et al. (1961) studied *Heterobilharzia americana* in southern Louisiana and found the raccoon to be the principal definitive host. Kaplan (1964) was the first to report *H. americana* from the opossum and commented on its rarity in marsupials. In addition to these previously reported trematodes we have identified seven species, one from the otters and six from the raccoons, that have not been reported from Louisiana and are of importance from either epidemiological or zoogeographical standpoints.

Family DIPLOSTOMIDAE Poirier,
1886

Alaria mustelae Bosma, 1931
(Figure 1)

Synonyms: *Alaria freundi* Sprehn, 1932; *A. intermedia* (Olivier and Odlaug, 1938) Odlaug, 1940; *A. dubia* Chandler and Rausch, 1946; *A. minuta* Chandler and Rausch, 1946; *A. taxidea* Swanson and Erickson, 1946; *A. canadensis* Webster and Wolfgang, 1956.

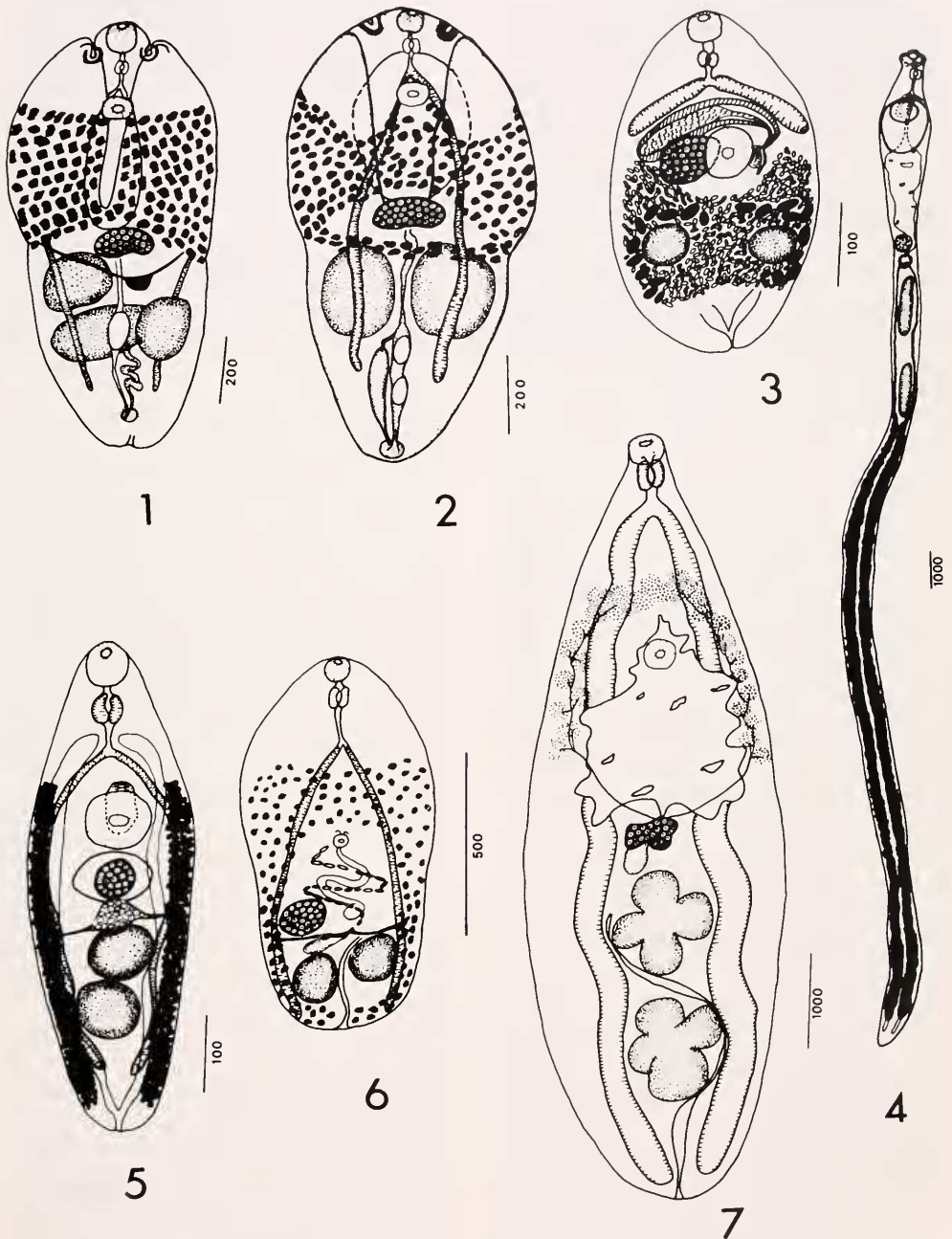
Hosts: *Procyon lotor* (Linn.).

Location: Small intestine.

Localities: Bayou Duplantier (East Baton Rouge Par.); 2 mi. N. of Hwy. 190 on Atchafalaya River (Pointe Coupee Par.). Univ. Nebraska State Mus., Manter Lab. Coll. No. 21194

Diagnosis (based on ten mature specimens): Body indistinctly bisegmented, 1250 (1160-1420) long; forebody scoop-shaped, 680 (650-770) long by 565 (500-580) wide, with pseudosuckers present on both sides of oral sucker; hindbody conical, 540 (460-650) long by 470 (450-530) wide, containing reproductive organs. Forebody cuticle completely covered with small spines; hindbody smooth. Oral sucker terminal, 86 (80-95) long by 81 (70-90) wide. Prepharynx present, short. Pharynx 66 (60-70) long by 48 (45-50) wide. Esophagus short, often not apparent. Ceca terminate near posterior end of body. Acetabulum wider than long, 73 (70-80) long by 90 (85-93) wide. Holdfast broadly oval, variable in size, anterior extension partially or completely covers the acetabulum. Testes two, not equal; anterior testis irregularly oval, laterally displaced on either side of midline, 188 (155-230) long by 206 (190-230) wide; posterior testis dumbbell-shaped, much wider than anterior testis, 183 (150-220) long by 335 (355-400) wide, posterior testis with ventro-medial groove to allow passage of ceca and uterus. Seminal vesicle expanded into a muscular ejaculatory duct. Ovary reniform, located at forebody-hindbody juncture, 94 (90-100) long by 147 (135-155) wide. Mehlis gland opposite anterior testis. Uterus makes an initial course into holdfast region and then passes posteriorly emptying into the genital atrium. Genital atrium posterior, subterminal on dorsal surface. Vitellaria occupies much of the forebody from the acetabulum to anterior testis, never observed posterior to anterior testis. Vitelline ducts unite to form a vitelline reservoir at the level of anterior testis. Eggs large, few, 106 (102-110) long by 63 (60-65) wide. Excretory pore subterminal on ventral side.

Discussion: Babero (1960) tentatively listed *Alaria taxidea* as an intestinal inhabitant of the skunk, *Mephitis mephitis*, in Louisiana. Johnson (1979) relegated



Figures 1-7. 1. *Alaria mustelae*, ventral view, from *Procyon lotor*. 2. *Pharyngostomoides procyonis*, ventral view, from *Procyon lotor*. 3. *Maritreminoides nettae*, ventral view, from *Procyon lotor*. 4. *Baschkirovitrema incrassatum*, ventral view, from *Lutra canadensis*. 5. *Gyrosoma singulare*, ventral view from *Procyon lotor*. 6. *Apophallus venustus*, ventral view, from *Procyon lotor*. 7. *Parametorchis complexus*, ventral view, from *Procyon lotor*. Scale in micrometers.

A. taxidea to a junior synonym of *A. mustelae* based on life history and host specificity for mustelids. He demonstrated that specimens of *A. mustelae* differed in size and morphology when recovered from different mustelid hosts. He found no natural *A. mustelae* infection in the raccoons he examined, but 1000 mesocercariae fed to a single raccoon yielded 14 adults. They were similar morphologically to those from mustelid infections, but were decidedly smaller. Bosma (1934) stated that she recovered only *A. mustelae* metacercariae from raccoons.

This is the first report of natural infections of adult *Alaria mustelae* in raccoons. We found two of thirty raccoons infected. One infection consisted of fifteen worms whereas the second infection consisted of several hundred mature adults in the small intestine. Our specimens are smaller (1.160-1.420 mm) compared to the upper range (2.4 mm) of the species reported by Johnson (loc. cit.), but are larger than his specimens from the experimental infections in the raccoon (0.88-1.00 mm). Unfortunately Babero (loc. cit.) did not list measurements for his specimens from skunks and we were unsuccessful in gaining access to them. However, we concur that *A. taxidea* is a synonym of *A. mustelae* and that the low number of naturally infected raccoons, small size of worms, and the low number of adults recovered in experimental infections of raccoons indicates a physiological specificity for mustelids.

Of interest from an epidemiological standpoint, Beaver et al. (1977) reported a mesocercarial infection in a human in Louisiana. They believed the mesocercariae members of the genus *Alaria* and traced the infection to the consumption of an undercooked raccoon. Johnson (loc. cit.) has proven experimentally, and we have found in nature, that raccoons may serve as definitive hosts for *A. mustelae*. However, given the low specificity of *A. mustelae* for raccoons and the complex migration of all species

of *Alaria* in the definitive host (gut to lungs and back to gut) some mesocercariae may lose their way and lodge in other tissues. We have evidence to this effect in other species of *Alaria* (to be presented elsewhere). This indicates that the raccoon is not only a definitive but a paratenic host as well.

Pharyngostomoides procyonis Harkema, 1942
(Figure 2)

Synonyms: *P. ovalis* Chandler and Rausch, 1946.

Hosts: *Procyon lotor* (Linn.)

Location: Small intestine.

Localities: St. Landry, Pointe Coupee, Iberville, St. Martin, East Baton Rouge, Ascension, and Livingston parishes.

Univ. Nebraska State Mus., Manter Lab. Coll. No. 21195.

Diagnosis (based on ten mature specimens): Body indistinctly bisegmented, 1160 (1080-1250) long; forebody scoop-shaped, 580 (520-620) long by 570 (520-630) wide, with pseudosuckers present on both sides of the oral sucker; hindbody conical, 580 (540-620) long by 506 (450-550) wide. Forebody cuticle completely covered with small spines; hindbody smooth. Oral sucker terminal, 74 (70-75) long by 90 (80-95) wide. Prepharynx 10 (5-15) long. Pharynx muscular, 57 (50-60) long by 51 (45-55) wide. Esophagus 22 (20-25) long. Ceca extend just posterior to testes, never reaching posterior end of body. Acetabulum spherical, posterior to intestinal bifurcation, 77 (75-80) long by 78 (75-80) wide, artially or completely covered by holdfast organ. Holdfast well developed, elongate, broadly oval, may reach as far as pharynx. Testes equal, spherical or oval, opposite but often diagonal, 237 (200-250) long by 200 (180-230) wide, located in hindbody dorsal to ceca. Seminal vesicle coiled, posterior to testes, expanded into a muscular ejaculatory pouch, that terminates in a genital cone. Genital atrium posterior, subterminal on dorsal side. Ovary reniform or trans-

versely oval, anterior to testes, 90 (85-100) long by 137 (125-160) wide. Uterus makes a short ascending loop into hold-fast region, turns posteriorly and unites with ejaculatory pouch. Vitellaria mainly in forebody, extending from acetabulum to the anterior margin of testes. Vitelline ducts unite just posterior to ovary to form the vitelline reservoir. Eggs few, large, 92 (90-95) long by 60 (58-62) wide. Excretory pore subterminal on ventral side.

Discussion: *Pharyngostomoides* is a stenoxenic genus reported only from raccoons. Harkema (1942) described *P. procyonis* from raccoons in North Carolina and Texas. *P. ovalis* was subsequently described by Chandler and Rausch (1946) in Michigan and was later synonymized with *P. procyonis* by Dubois (1963). Harkema and Miller (1964) surveyed raccoons from North Carolina, South Carolina, Georgia, Florida, and Virginia and found *P. procyonis* present in each state. Further, they noted that there appeared to be two forms present in the raccoon. Beckerdite et al. (1971) raised both of these forms to full species. They described *P. adenocephala* and separated it from *P. procyonis* on the basis of: 1) larger size; 2) shape (*spathulate rather than scoop-shaped*); 3) presence of pseudosucker glands; 4) absence of an ejaculatory pouch; and 5) morphology of larval stages.

Based on our diagnosis we conclude that our specimens belong to *P. procyonis*. We are not able to compare the morphology of the larval stages since the life history in Louisiana is unknown. We have found *P. procyonis* to be the most frequent parasite encountered in raccoons; 29 of 30 examined were infected with this worm. The only exception was a raccoon collected near a residential area of Baton Rouge. Infections ranged up to an estimated 5000 worms in one raccoon.

Family MICROPHALLIDAE

Travassos, 1920

Maritreminoides nettae (Gower, 1938)

Rankin, 1939

(Figure 3)

Synonyms: *Maritrema nettae* Gower, 1938; *Pseudospelotrema nettae* (Gower, 1938) Hunter and Vernberg, 1953.

Hosts: *Procyon lotor* (Linn.).

Location: Small intestine.

Localities: Atchafalaya R. at Krotz Springs (St. Landry Par.); 5 mi. N. of Butte La Rose on Atchafalaya R. (St. Martin Par.); 10 mi. S. of Ramah on East Atchafalaya Protection Levee (Iberville Par.).

Univ. Nebraska State Mus., Manter Lab. Coll. No. 21196

Diagnosis (based on ten mature specimens): Body small, pyriform, 407 (390-420) long by 231 (220-270) wide. Cuticle completely covered with small spines. Oral sucker subterminal, 45 (37-50) long by 57 (55-61) wide. Prepharynx 25 (15-33) long. Ceca short, thickwalled, bifurcating anterior to cirrus sac and extending toward edges of body; never extending past anterior level of acetabulum, 130 (120-143) long. Acetabulum pre-equatorial, larger than oral sucker, 63 (57-66) long by 63 (61-68) wide. Testes spherical, opposite, equal in size, 71 (60-83) long by 70 (60-77) wide. Cirrus sac crescent-shaped, transverse, pre-acetabular; walls of cirrus sac thick with well developed seminal vesicle, prostate, and ejaculatory duct; ejaculatory duct extends into a slender, protrusible cirrus. Genital atrium opens sinistral to acetabulum; atrium armed with small, stout spines. Ovary irregularly oval, usually overlapping acetabulum, 71 (64-81) long by 79 (75-80) wide. Uterus consists of loops between acetabulum and posterior stem of excretory vesicle. Vitellaria form a right angle to testes with the sides being anterior and lateral to each testis, a few follicles extend posterior to testes but never reach end of body. Eggs small,

numerous, 20 (20-22) long by 11 (10-11) wide. Excretory pore terminal; excretory vesicle V-shaped.

Discussion: Rankin (1939) erected the genus *Maritreminoides* for those microphallids with a long, protrusible cirrus and antero-lateral uterine coils. He placed in his genus *M. nettae* and two metacercarial forms from fishes; *M. obstipum* (Van Cleave and Mueller, 1932) and *M. medium* (Van Cleave and Mueller, 1932). Etges (1953) regarded the genus *Maritreminoides* valid, but transferred *M. obstipum* and *M. medium* into the genus *Maritrema* Nicoll, 1907 because they did not possess a protrusible cirrus. Sogandares-Bernal (1965) surveyed crayfishes in Louisiana for parasites and reported *Maritrema obstipum* from *Cambarellus shufeldti* (Faxon, 1881) and *Procambarus clarkii* (Girard, 1852). The metacercaria figured by Sogandares-Bernal is morphologically identical with the adult worms we have found in raccoons except for lacking a protrusible cirrus and being ovigerous. Presumably, Sogandares-Bernal assigned the metacercariae to the genus *Maritrema* based on the absence of a protrusible cirrus.

We believe the metacercariae found in crayfishes by Sogandares-Bernal (loc. cit.) to be the larval stage of the adults we have collected from raccoons. The fact that a cirrus was not figured for the metacercaria could well have been because the worms were immature. Functionally, a protruded cirrus in a metacercarial stage, unless progenetic, would be of dubious value. The location of the infected crayfishes, as reported by Sogandares-Bernal, is in the same basin as are the infected raccoons. We have observed crayfish remains in many raccoons.

Though *Maritreminoides nettae* was described from ducks in Michigan (Gower, 1938), Harkema and Miller (1964) reported it from raccoons in North Carolina, South Carolina, and Georgia.

We reported the finding of *M. nettae* in the small intestine of seven of thirty raccoons in Louisiana. We also report what we believe to be the second intermediate host, i.e. the crayfishes of Sogandares-Bernal (loc. cit.). If life histories of closely related forms are examined, the first intermediate host of *M. nettae* is most probably an amnicolid snail.

Family ECHINOSTOMATIDAE

(Looss, 1902) Poche, 1926.

Baschkirovitrema incrassatum (Diesing, 1850) Skrjabin, 1944

(Figure 4)

Synonyms: *Dipostomum incrassatum* (Diesing, 1850; *Echinostomum incrassatum* (Diesing, 1850) Stossich, 1891.

Hosts: *Lutra canadensis* Schreber.

Location: Small intestine.

Locality: Lake Verret (Assumption Par.)

Univ. Nebraska State Mus., Manter Lab., Coll. No. 21197.

Diagnosis (based on 14 mature specimens): Body elongate, slender, 27.5. (23-31) mm long. Maximum width at level of acetabulum, 1170 (1100-1300). Head color reniform, 546 (500-580) wide, bearing 27 spines; a double row of 4 corner spines on each side, 148 (140-160) long by 42 (35-50) wide; six lateral spines on each side are found in a single row and are increasingly larger from ventral to dorsal side, the largest lateral spine, 121 (100-145) long by 26 (25-30) wide; 7 dorsal, uninterrupted spines, 132 (120-150) long by 25 (24-26) wide. Oral sucker 262 (220-280) long by 287 (250-300) wide. Prepharynx 142 (130-150) long. Pharynx 240 (220-250) long by 170 (140-200) wide. Esophagus 690 (600-800) long. Ceca two, terminating near posterior end of body. Acetabulum very prominent, muscular, located in anterior fifth of body, 1190 (1100-1400) long by 990 (900-1050) wide. Testes tandem, elongate, oval, in anterior third of body; anterior testis 1190 (970-1450) long by 265 (200-320) wide; posterior testis 1090 (870-1400) long by 246 (200-310) wide.

Vas efferens originate on antero-lateral side of testes and unite at posterior margin of the acetabulum; cirrus sac dorsal, not extending posterior to the acetabulum, 1150 (1100-1400) long by 500 (400-550) wide; cirrus long, slender, and unarmed. Ovary round, dextral to midline, 300 (240-350) long by 260 (250-280) wide. Mehlis gland diffuse, immediately posterior to ovary. Uterus with short descending coil; ascending uterus forms transverse intercaecal loops between Mehlis gland and acetabulum; distal vessel of uterus forms a metraterm that opens at the common genital pore just anterior to acetabulum. Vitelline follicles extend from middle of anterior testis to posterior end of body, filling most of lateral space behind testes. Vitelline ducts originate at middle of anterior testis and unite to form a vitelline reservoir at level of Mehlis gland. Excretory pore terminal. Eggs abundant, 109 (105-115) long by 64 (60-66) wide.

Discussion: The geographical localities from which *Baschkirovitrema incrassatum* have been reported are of considerable interest. Braun (1901) described *B. incrassatum* from the otter, *Pteronura brasiliensis* Zimmerman, in South America; Beverly-Burton (1960) and Myers et al. (1960) report *B. incrassatum* from *L. maculicollis* Lichtenstein and *Aonyx capensis* (Schinz) from Africa; and Sawyer (1961), Harkema and Miller (1968), and Fleming et al. (1977) have identified *B. incrassatum* from *L. canadensis* in North America.

Harkema and Miller (loc. cit.) reported *B. incrassatum* from North Carolina and stated that they compared their specimens with those of Sawyer (loc. cit.) from Georgia and to specimens deposited in the National Museum by W. J. Hamilton from otters in New York. They reported all specimens from North America were similar and that they "compared favorably" with the measurements given by Beverly-Burton (loc. cit.) from Africa. The present report is the first to present measurements from

North American material. We have found that our specimens from Louisiana are much larger than those reported from South America (Braun, 1901) and from Africa (Beverly-Burton, 1960) and with no apparent overlap (Table 1). In addition, the oral sucker and acetabulum of our specimens are proportionately larger than previously described.

As indicated by the measurements, our specimens are more closely aligned with the material from South America than those from Africa. Since life histories of any of these forms are enigmatic, it is difficult to ascribe differences at this time to intra- or interspecific variation.

Family PSILOSTOMIDAE Looss, 1900

Gyrosoma singulare Byrd, Bogitsh,
and Maples, 1961

(Figure 5)

Synonyms: Originally described as *Grysoma singularis* Byrd et al., but Yamaguti (1971) emended the genus to *Gyrosoma*.

Hosts: *Procyon lotor* (Linn.).

Location: Small intestine.

Localities: Bayou Duplantier and Spanish Lake (East Baton Rouge Par.); Atchafalaya R. between Keith Lake and Krotz Springs (St. Landry Par.); and Head of Island (Livingston Par.). Univ. Nebraska State Mus., Manter Lab. Coll. No. 21198.

Diagnosis (based on ten mature specimens): Body lanceolate, relatively thick, 632 (580-680) long; widest at level of acetabulum, 222 (200-265) wide. Cuticle thick, beset with short, stout spines; spines set in dense rows anteriorly and become less numerous behind the posterior testis. Oral sucker subterminal, 55 (52-59) long by 56 (52-59) wide. Prepharynx 15 (13-17) long. Pharynx barrel-shaped, 35 (30-41) long by 36 (33-39) wide. Esophagus distinct, 14 (22-41) long. Ceca bifurcating anterior to common genital pore, diverge laterally to acetabulum and terminate midway between posterior testis and caudal end of body. Acetabulum prominent, pre-

Table 1. Comparative measurements of *Baschkirovitrema incrassatum* from Africa, South America, and North America.

	Africa Beverly-Burton (1960)	South America Braun (1901)	North America (present study)
Body length	12.50-16.55 mm	7-19 mm	27.5 (23-31) mm
No. of head spines	27	27	27
Corner spines	108-154 X 28-37	104 X 31	148 (140-160) X 42 (35-50)
Lateral spines	105-130 X 28-32	—	121 100-145) X 26 (25-30)
Dorsal spines	109-144 X 30-34	83-93 X 21	132 (120-150) X 25 (24-26)
Oral sucker: length	190-220	166-250	262 (220-280)
Oral sucker: diameter	220-260	187-208	287 (250-300)
Acetabulum: length	870-1170	—	1190 (1100-1400)
Acetabulum: diameter	810-950	1000	990 (900-1050)
Pharynx: diameter	120-210	73-83	170 (140-200)
Testes: length	1120-1500	1000	1140 (870-1450)
Testes: diameter	320-480	400	256 (200-320)
Ovary: length	320-390	330	300 (240-350)
Ovary: diameter	320-370	266	260 (250-280)
Eggs	108-123 X 54-62	104 X 73	109 (105-115) X 64 (60-66)

equatorial, 89 (81-92) long by 82 (70-92) wide. Testes oval, diagonal (rarely tandem), contiguous and often overlapping; anterior testis 76 (66-88) long by 85 (81-96) wide; posterior testis 86 (72-96) long by 83 (77-94) wide. Cirrus sac prominent, dorsal to acetabulum, containing seminal vesicle, well developed prostate, and a short, muscular cirrus. Genital pore midventral between cecal bifurcation and acetabulum; a well developed sphincter muscle is observed when the genital pore is constricted. Ovary ovoid, lying immediately postero-dorsal to acetabulum, 45 (42-48) long by 42 (40-44) wide. Uterus short, ascends directly to genital pore; usually only one egg observed in the uterus at one time, but occasionally two. Egg thick-shelled, large in comparison with body size, 105 (100-110) long by 64 (60-75) wide. Vitellaria extend laterally from the genital pore to caudal end of body; each follicle composed of large, clearly defined vitelline cells. Vitelline ducts extend medially

between testes and acetabulum to form a large vitelline reservoir. Excretory system composed of a terminal excretory pore; a Y-shaped excretory vesicle that bifurcates at caudal end of ceca; and arms that extend anteriorly to level of the pharynx.

Discussion: The genus *Gyrosoma* was created by Byrd et al. (1961) to accommodate specimens collected from a single raccoon in Georgia. They considered these worms to be distinct from other psilostomids based on: 1) the diagonal arrangement of the testes; 2) triangular shape of the testes; 3) a short uterus; and 4) a single, large egg in the uterus. To our knowledge, the only other mention in the literature of *G. singulare* is that of Harkema and Miller (1964) who state that they have also found it in Georgia and South Carolina.

We have collected *G. singulare* from the small intestine of 24 raccoons in Louisiana. Infection ranged from a few to several hundred worms. This appar-

ently stenoxenic species is most easily distinguished by the presence of a large egg which may approach one fourth the size of the worm. No morphological data have been reported for this species other than that contained in the original description. Our measurements significantly extend the size range of this species (580-680 compared to 290-480) and we find that our specimens have more spherical shaped testes than the triangular or half-mooned shape reported by Byrd et al. (loc. cit.).

Family HETEROPHYIDAE (Leiper, 1909) Odhner, 1914

Apophallus venustus (Ransom, 1920) Cameron, 1936

(Figure 6)

Synonyms: *Cotylophallus venustus* Ransom, 1920; *C. similis* Ransom, 1920; *Rossicotrema venustum* Ciurea, 1924.

Hosts: *Procyon lotor* (Linn.).

Location: Small intestine.

Locality: 10 mi. S of Ramah on the East Atchafalaya Protection Levee (Iberville Par.).

Univ. Nebraska State Mus., Manter L2b. Coll. No. 21199

Diagnosis (based on ten mature specimens): Body elongate, oval with a slight constriction between acetabulum and ovary, 1018 (820-1150) long by 563 (450-650) wide. Cuticle with small spines over anterior two thirds; posterior devoid of spination. Oral sucker unornamented, subterminal, 56 (46-66) long by 70 (55-79) wide. Prepharynx distinct, 13 (11-24) long. Pharynx 54 (50-57) long by 52 (48-55) wide. Esophagus long and slender, 123 (99-132) long. Ceca extend to caudal end of body. Acetabulum small, weakly defined, located in genital sinus posterior to genital openings, 41 (31-44) long by 41 (39-44) wide. Testes oblique, globular or ovoid; anterior testis 129 (99-154) long by 163 (99-187) wide; posterior testis 133 (110-165) long by 180 (150-224) wide. Vas efferens unite at level of ovary to form a conspicuous sigmoid seminal vesicle. Cirrus absent. Ovary ovoid, dextral to midline, 104 (99-115) long by 110 (99-

125) wide. Seminal receptacle large, transversely oval, and lying directly posterior to ovary. Uterus makes 3-4 transverse, intercaecal loops before entering genital sinus. Vitellaria unite across body between the intestinal bifurcation and acetabulum, then extend laterally to posterior end of body. Vitelline ducts unite to form a vitelline reservoir between seminal vesicle and testes. Eggs 35 (33-37) long by 20 (17-22) wide. Excretory pore terminal; posterior stem of excretory vesicle sigmoid as it courses between the testes.

Discussion: *Apophallus venustus* has, heretofore, been reported from eastern coastal states and provinces of North America (Cameron, 1936; Babero and Shepperson, 1958; and Harkema and Miller, 1964). Yamaguti (1971) considers *A. venustus* conspecific with its European relative *A. donicus* (Skrjabin and Lindrop, 1919) Price, 1931, but we prefer to follow Cameron (loc. cit.) and recognize *A. venustus* as a distinct species based on its greater anterior extent of vitellaria and its larger size.

The life history of *A. venustus* was studied by Cameron (1937,a) and consists of an operculate snail, *Goniobasis livescens* (Menke), as first intermediate host, a wide variety of fishes as second intermediate host, and any fish-eating mammal as the definitive host. Cameron (1937,b) reported a human infection in Canada with *A. venustus* eggs being found in the feces. The epidemiology was traced to the presumed ingestion of fish.

The presence of *A. venustus* in Louisiana is of epidemiological interest since many of its people subsist, to a large degree, off the land. Small infections may perhaps go unnoticed because adequate diets prevent loss of vigor. However, Africa et al. (1935), working in the Philippines, found a high correlation between cardiac alteration and heterophyid infection. Kean and Breslau (1964) state that a large number of cardiac fatalities (14.6%) in the Philip-

piners are attributed to heterophyid eggs which find their way into the circulation. These reports, coupled with the already mentioned human infection with *A. venustus* should alert epidemiologists and pathologists to the presence of this speies and its possible involvement inhuman infection in Louisiana.

We found four of thirty raccoons infected with *A. venustus*. The infections were located throughout the small intestine and not localized only in the jejunum and ileum as reported by Cameron (1937, a).

Family OPISTHORCHIIDAE Braun, 1901

Parametorchis complexus (Stiles and Hassal, 1894) Skrjabin, 1913
(Figure 7)

Synonymis: *Ditoma complexum* Stiles and Hassal, 1894.

Hosts: *Procyon lotor* (Linn.).

Location: Biliary system.

Localities: Sherburne (Pointe Coupee Par.); 10 mi. S. of Ramah (Iberville Par.).

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Diagnosis (based on ten mature specimens): Body flat, elongate, anterior end attenuate and posterior rounded, 7.8 (6.0-10.5) mm long by 2.2 (1.6-2.9) mm wide. Entire cuticle spinous; spines less dense posterior to testes. Oral sucker terminal, 272 (230-320) long by 326 (330-400) wide. No prepharynx. Pharynx muscular, 253 (210-290) long by 233 (220-270) wide. Esophagus short, 113 (70-150) long. Ceca large, coursing sinuously around organs until reaching posterior end of body. Acetabulum weak, inconspicuous, located in anterior one fourth of body, 286 (260-330) long by 305 (280-330) wide. Testes tandem, lobate, located in posterior half of body; anterior testis 913 (670-1250) long by 956 (800-1150) wide; posterior testis usually larger and possessing more lobes, 994 (800-1400) long by 955 (730-1200) wide. Vas deferens enlarged to form seminal vesicle that courses anteriorly, dorsal to

uterus, and empties into genital pore. Genital pore located ventrally, midway between acetabulum and medially positioned vitellaria. Ovary trilobed, pretesticular, 405 (300-500) long by 494 (390-610) wide. Seminal receptacle variable in shape, usually larger than ovary, lying immediately posterior to, and often overlapping, the ovary. Uterus voluminous, with tightly packed loops loosely bordered by the ceca, occupying most of the space between ovary and acetabulum. Vitellaria laterally displaced in anterior half of body; unite medially between intestinal bifurcation and genital pore. Vitelline ducts unite ventral to ovary to form a vitelline reservoir. Eggs oval, some constricted anteriorly, 28 (26-30) long by 16 (15-17) wide. Excretory pore terminal; posterior stem of excretory vesicle sigmoid as it passes between testes, eventually giving rise to a Y-shaped excretory vesicle.

Discussion: Stiles and Hassal (1894) originally described *P. complexus* from specimens found in the biliary system of cats in Maryland and New York. Since that time, additional species have been described from the biliary system of carnivores: *P. noveboracensis* Hung, 1926 from the cat; *P. intermedius* Price, 1929 from the fox, *Vulpes fulva* (Desmarest); *P. canadensis* Price, 1929 from *Mustela vison*; and *P. manitobensis* Allen and Wardle, 1934 from the dog. Cameron (1944) examined the morphology of these worms and concluded that the latter four species were synonyms of *Metorchis conjunctus* (Cobbold, 1860) Looss, 1899. He based his separation on the anterior disposition of the vitellaria. In *M. conjunctus* the vitellaria are laterally displaced while the genus *Parametorchis* is characterized by the anterior union of the vitellaria. Cameron's proposal left *Parametorchis* a monotypic genus. Yamaguti (1971) incorrectly stated that Cameron synonymized *P. intermedius*, *P. canadensis*, *P. noveboracensis*, and *P. manitobensis* with *P. complexus*.

Harkema and Miller (1964) reported *P. complexus* from one of 320 raccoons they examined in the southeastern United States (the infected raccoon was found in North Carolina). We have found *P. complexus* in five raccoons in Louisiana. The worms inhabit all levels of the biliary system. One raccoon harbored 91 mature *P. complexus* and the bile duct exhibited marked hypertrophy.

SUMMARY

The following trematodes were collected from small mammals in southern Louisiana: *Alaria mustelae* Bosma, 1931; *Fibricola cratera* (Barker and Noll, 1915) Dubois, 1932; *F. lucida* (La Rue and Bosma, 1927) Dubois and Rausch, 1950; *Pharyngostomoides procyonis* Harkema, 1942; *Heterobilharzia americana* Price, 1929; *Apophallus venustus* (Ransom, 1920) Cameron, 1936; *Parametorchis complexus* (Stiles and Hassal, 1894) Skrjabin, 1913; *Baschkirovitrema incrassatum* (Diesing, 1850) Skrjabin, 1944; *Brachylaima virginianum* Dickerson, 1930; *Gyrosoma singulare* Byrd, Bogitsh, and Maples, 1961; *Hasstilesia texensis* Chandler, 1929; *Maritreminoides nettae* (Gower, 1938) Rankin, 1939; and *Rhopalias macracanthus* Chandler, 1932.

Trematodes reported from Louisiana for the first time are: *Alaria mustelae*, *Pharyngostomoides procyonis*, *Maritreminoides nettae*, *Baschkirovitrema incrassatum*, *Gyrosoma singulare*, *Apophallus venustus*, and *Parametorchis complexus*.

The raccoon is a new definitive host for *A. mustelae*. *A. mustelae* shows a distinct specificity for mustelids rather than procyonids based on larger size of worms, low number of naturally infected raccoons, and the low number of adults recovered from experimentally infected raccoons. During migration of larval *A. mustelae* in the raccoon, mesocercariae may lose their way and lodge in other

tissues. The raccoon is, then, both a definitive and paratenic host. This finding becomes important in light of the recent report of *Alaria mesocercariae* in man in Louisiana (Beaver et al., 1977).

Pharyngostomoides procyonis is the most frequently encountered trematode in raccoons in Louisiana. Though it has been reported from the eastern coastal states and Texas, it likely is found throughout the other Gulf Coast states as well.

Metacercariae reported in crayfishes as *Maritrema obstipum* by Sogandares-Bernal (1965) are identical to adult *Maritreminoides nettae* recovered from raccoons, except for a protrusible cirrus and being ovigerous. The infected crayfishes are found in the same river basin as are the infected raccoons. We propose that they are the same species based on morphological, geographical and ecological criteria.

Specimens identified as *Baschkirovitrema incrassatum* have been reported in otters from North America, South America, and Africa. Since speciation in otters has occurred, these worms possibly may be in the process of pursuing distinct evolutionary pathways. Our specimens from North America are much larger than previously reported and with no apparent overlap. Based on reported measurement, our specimens notably are more closely aligned with the material from South America than from Africa.

The presence of *A. venustus* in Louisiana is of epidemiological significance since a human infection involving this species has been previously reported. The metacercariae of *A. venustus* is found in fish and all fish-eating mammals are susceptible, including humans. Since other heterophyids have been found to be the cause of cardiac fatalities, both epidemiologists and pathologists should be aware of its presence and the possible involvement in human infection in Louisiana.

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